CONCEPTUAL SITE MODEL

OPERABLE UNIT DEFINITIONS

In regulations contained in the National Contingency Plan (40 CFR Part 300), EPA established several program management principles to be considered when conducting Superfund remedial investigations and feasibility studies. One of these principles is that large and complex sites should be divided into "Operable Units" when necessary to phase the cleanup and/or to expedite early actions. Following this management principle, EPA divided the Libby Site into the following Operable Units (OUs):

- OU1. The former Export Plant is defined geographically by the property boundary of the parcel of land that included the former Export Plant.
- OU2. The exact geographic area of OU2 has not yet been defined, but includes areas impacted by contamination released from the former Screening Plant. These areas include the former Screening Plant, the Flyway property, the Highway 37 Right-of-Way adjacent to the former Screening Plant and/or Rainy Creek Road, the Wise property, and the KDC Bluffs. The KDC Bluffs area is located directly across the Kootenai River from the former Screening Plant.
- OU3. The mine OU includes the former vermiculite mine and the geographic area (including ponds) surrounding the former vermiculite mine that has been impacted by releases from the mine, including Rainy Creek and the Kootenai River. Rainy Creek Road is also included in OU3. The exact geographic area of OU3 has not yet been defined but will be based primarily upon the extent of contamination associated with releases from the former vermiculite mine.
- OU4. OU4 is defined as residential, commercial/industrial (not associated with former W.R.Grace operations), and public properties, including schools and parks, within the boundary depicted on Figure 1, or those which have received material from the mine not associated with W.R. Grace operations. Highway transportation corridors such as Highway 37 (including the five miles of Highway 37 beginning at the intersection of Rainy Creek Road and extending into the town of Libby) are also included in OU4. Portions of Highway 37 associated with the Screening Plant are addressed in OU2 and are therefore excluded from OU4.
- OU5. The former Stimson Lumber Mill is defined geographically by the parcel of land that included the former Stimson Mill.
- OU6. The rail yard owned and operated by the Burlington Northern and Santa Fe Railroad (BNSF) is defined geographically by the BNSF property boundaries and extent of contamination associated with the rail yard. Railroad transportation corridors are also included in this OU.
- OU7. The Troy OU includes all residential, commercial, and public properties within the town of Troy.

These OUs may be refined or revised in the future, as needed to optimize the Site investigation and clean-up actions.

PATHWAYS OF HUMAN EXPOSURE IN OU4

Conceptual Site Model

The first step in developing a risk assessment at a site or an Operable Unit is usually the development of a conceptual site model (CSM). The purpose of a CSM is to organize and graphically display likely sources of contaminants, mechanisms of contaminant release to the environment, likely pathways by which contaminants may be migrating in the environment, and likely routes by which humans might come into contact with contaminants in the environment (USEPA 1989). The CSM then helps guide initial investigations on the nature and extent of contamination at the site, and may be updated or revised periodically during the course of the site investigation as more data become available.

This risk assessment focuses on exposure pathways under current and future land use scenarios that apply to residents and workers who reside, work, or attend school in or about the community of Libby (OU4). This includes an assessment of exposures in Libby at properties that have been cleaned up and also at those properties that have not been cleaned up. For properties that have been cleaned up, both pre-cleanup and post-cleanup conditions will be assessed. For properties that have not been cleaned up, exposures will be assessed as pre-cleanup (current) conditions. The potential impact of historical exposures (e.g., past occupational exposures) on receptors in OU4 is discussed in a qualitative manner in the risk assessment. Potential future releases (those that may occur after cleanups are complete) will be addressed through Institutional Controls and Operations and Maintenance procedures.

As noted previously, the contaminant of concern in OU4 is a form of asbestos referred to as Libby amphibole (LA). Figure 2 presents a conceptual model for human exposure to LA at the Site. This model has been developed based on EPA's current understanding of sources and likely pathways of transport or migration and potential human exposure to LA in OU4. Because inhalation of LA fibers in air is the primary exposure route of concern, only inhalation pathways are included in this CSM. Exposure to LA by ingestion of contaminated soil, sediment, dust, or water might also be occurring at the Libby Site, but these exposure pathways are currently believed to be a minor source of health risk compared to the inhalation pathways.

Not all inhalation exposure pathways to LA shown in Figure 2 are likely to be of equal concern. In the figure, a black dot is used to show exposure pathways that are considered the most likely to be complete and potentially significant for each receptor, and where a quantitative assessment of risk will be performed. In a quantitative assessment, data from the site are used to derive numeric estimates of the magnitude of health risk in exposed people. Boxes with an open circle indicate exposure pathways that may be complete, but these exposures are believed to be minor compared to other exposures that are occurring, and are assessed qualitatively. This approach may include a presentation of information on the relative magnitude (e.g., negligible, small, moderate) of the exposure compared to the total exposure, and may also include an assessment of the strength of evidence for

each of those exposures and rank them individually for use in the qualitative evaluation (i.e, IRIS weight-of-evidence approach). Boxes with a question mark indicate pathways that may be complete, but where current data are not sufficient to judge whether the pathway is likely to be significant. EPA may seek to collect additional data in the future to allow evaluation of these pathways, as deemed necessary. Boxes that are open (no symbol) indicate that the exposure pathway is not complete, or if complete, is likely to be negligible.

Other exposure pathways that may also be of concern at the Site will be evaluated during on-going investigations and evaluations for the other OUs at the Site. For example, it is anticipated that the evaluation for OU3 (the mine) will include an assessment of exposures of workers and recreational visitors in forests and other public areas near the mine, and will also include an assessment of exposures associated with releases along Rainy Creek Road. Similarly, mine-related exposures that occur in and about the community of Troy will be evaluated as part of OU.

Sources of LA Asbestos

Ultimately, all pathways of exposure to LA in and about the community of Libby may be traced back to the mine and the mining, milling, and production operations associated with the mine. It is believed that the most important sources causing past and/or current releases of LA into the environment include the following:

1. *Mine, Mill, and Processing Facilities.* When the mine, mill, and processing facilities were operating, activities at these locations released LA fibers into the air (MRI 1982). Although the mine and processing facilities are no longer operating, airborne release of fibers from exposed asbestos-contaminated soils, exposed ores, or other contaminated outdoor surfaces at these facilities is likely still occurring, albeit at a lower rate than in the past.

2. *LA Contaminated Surface Soils and Outdoor Surfaces.* Airborne fibers released from the mine, mill, and processing facilities would have been carried by the wind in a down-wind direction. Most fibers likely would fall to earth and lead to contamination of surface soils, surface water, and other exposed surfaces (e.g., some fibers may have been trapped in tree bark or deposited on surfaces of buildings, streets, etc.). Once contaminated, these soils and surfaces may serve as a continuing source of release and exposure.

3. *Solid Wastes.* Solid wastes generated at the former mine site or at milling and processing sites (the screening plant and the two export plants) may also be a source of past and/or current releases to the environment. At several locations in OU4, solid wastes known to have been deposited by W.R. Grace have resulted in exposures. In some cases, solid waste materials were used as fill or soil amendments in residential yards, gardens, and driveways. Solid waste materials also may have been used around public facilities, such as schools and ball fields, resulting in direct exposures through recreational activities. Solid waste product

may have spilled during transport and contaminated the margins of transportation corridors such as roads and rail lines.

4. *Vermiculite Product.* Product from the mine (unexpanded or expanded vermiculite) was used as insulation in a number of buildings in Libby. Because Libby vermiculite contains LA as a contaminant, the vermiculite insulation, if it exists in an unenclosed space, can serve as a continuing source of exposure to residents or workers who may come into contact with the vermiculite. In addition, vermiculite was often used a soil amendment in residential yards, gardens, driveways, etc. This vermiculite, once mixed with soil, may also represent a continuing source of exposure. Vermiculite product also may have been used around public facilities, such as schools and ball fields. Additionally, in some cases, vermiculite product may have spilled during transport and contaminated the margins of transportation corridors.

Migration Pathways in the Environment

There are three main ways by which LA may be transported within OU4:

1. *Airborne Transport.* Because LA fibers are small, they may become suspended in air from release mechanisms such as wind or mechanical disturbances (e.g., physical disturbance, vehicular and foot traffic, etc.). Once airborne, LA fibers will tend to move with the air. The time that the fibers remain in air (and hence the distance they may move before returning to earth) depends on the size of the particle and air flow turbulence, and may range from only a few minutes to a number of hours (USEPA 1985).

2. *Surface Water Transport.* Although asbestos is not soluble in water, suspended particles may be carried in surface water runoff (e.g., from rain or snowmelt) from the mine or other areas where soil is contaminated by LA, and deposited in soils or sediments at downstream locations. Fibers may then be released to the air from contaminated soils or dried sediments by either wind or mechanical disturbances.

3. *Bulk Transport.* Vermiculite and solid wastes that contain vermiculite or LA can be hauled from one place to another by humans for use in a variety of applications (e.g., fill or soil amendments in yards or gardens). In contrast to airborne and surface water transport pathways, which often can be reasonably well understood and predicted, the bulk transport pathway can result in the occurrence of asbestos contamination in nearly any location. In addition, contaminated soil and other similar material may be transported inadvertently by adherence to shoes or clothing, and can lead to contamination of dusts in homes, workplaces, schools; and vehicles.

Populations Evaluated in OU4

The OU4 risk assessment includes an evaluation of the following human populations that are likely to be exposed in and about the main residential and commercial areas of Libby:

- Residents. This includes children and adults who live in homes within the boundaries of OU4.
- Commercial Workers. This includes individuals who primarily work inside shops, stores, and other businesses located within the boundary of OU4. This population does not include people who work in Libby only occasionally or intermittently (as opposed to full time).
- Tradespersons. This includes people such as plumbers, electricians, home repair contractors, yard care workers, municipal workers, etc., who work at homes or businesses within the boundaries of OU4 on a regular basis and who may have contact with vermiculite insulation in indoor locations or contaminated soil in outdoor locations.
- Students/Teachers. This includes children who regularly attend school in Libby, along with the teaching and administrative staff at those schools.
- Recreational Visitors. This includes people who regularly engage in recreational or athletic activities at public lands (parks, open space) or facilities (ball fields, tracks, etc.) located within the boundaries of OU4. It is understood that most of these individuals may also be residents of Libby. Risks to out-of-town visitors or tourists who visit the Site and engage in recreational activities will be estimated from those computed for area residents, by adjusting for differences in exposure frequency and duration.

Exposure Scenarios Evaluated in OU4

Based on our current understanding of the past and present sources of release and transport of LA from the mine, the media and pathways that are believed to be the most likely to serve as important sources of human exposure in OU4 include the following:

1. *Breathing Outdoor Ambient Air.* Although general ambient air may be impacted by any activity that causes LA to be released from a source, it is currently believed that the main source of LA in general outdoor ambient outdoor air in the vicinity of Libby is release from contaminated soil in and around the community. This is because contaminated soils occur in multiple locations in and around Libby, and can serve as a continuous source of LA release into the air. Releases of LA from soil into outdoor ambient air may be due either to wind blowing over the soil, or from a variety of disturbances of the soil by human activity. Other sources that may also contribute to LA in outdoor ambient air include releases from contaminated soil and waste at the mine site itself, disturbances of LA from outdoor surfaces (roofs, sidewalks, streets, etc.) where it may have accumulated, burning of wood that has LA in the bark, structural fires in buildings that contain vermiculite insulation, etc. This exposure pathway is generally applicable to all populations.

2. *Breathing Indoor Air.* Indoor air exposures to LA may be divided into two main categories: 1) those that occur on a regular basis in the main living spaces of the home, workplace, or school, and 2) those that occur intermittently when someone enters into a non-living space such as an unfinished attic with unenclosed vermiculite.

   The *main living space* of a home, business, or school may become contaminated by several potential pathways, including: 1) leaking vermiculite insulation (if present) from walls or attics; 2) transport of contaminated material via clothes of a homeowner or tradesperson; 3) falling debris associated with a homeowner or tradesperson accessing an attic; 4) transport of contaminated outdoor soil into indoor dust *via* shoes, clothing, pets, etc.; 5) releases from contaminated wood used for burning (e.g., from logs carried indoors, releases during burning, disposal of ash, etc); and 6) outdoor ambient air. Once in indoor dust, LA may become suspended in indoor air by disturbance of the indoor dust by mechanical forces (air flow from heating or cooling systems) and a variety of normal human indoor activities (walking, playing, cleaning, etc.). This pathway is primarily applicable to residents, indoor workers, and students/teachers, but may also apply to tradespersons who regularly work in indoor locations. This pathway is considered to be negligible for recreational visitors, who are exposed mainly in outdoor locations.

   In an *unfinished attic space* (or any other non-living space, such as a crawl space, garage, shed, etc.) that contains unenclosed vermiculite insulation or other LA-containing material, nearly any activity that disturbs the material is likely to cause a release of vermiculite and/or LA fibers into the air of the non-living space. This pathway is likely to occur intermittently for residents who visit an unfinished attic or other unfinished space to place or retrieve stored items, but may be fairly common for a tradesperson who must enter such spaces to perform repairs on plumbing, wiring, etc. This pathway is likely to be infrequent for regular indoor commercial workers, students, and teachers, since they are not expected to enter such spaces, nor would it apply to recreational visitors.

   LA contained behind enclosed walls etc. does not present an open pathway for human exposure. However, breaches in the containment by various activities (e.g., home remodeling or repair) can result in airborne exposures and contamination to indoor dust. It is currently believed that such exposures are of concern primarily for tradespersons (carpenters, electricians, etc.) who may routinely encounter LA in homes and offices during their work. It is also recognized that homeowners and others may encounter LA during home renovation projects. This pathway is very unlikely to apply to regular indoor commercial workers, students or teachers, and is not applicable to recreational visitors.

A special case, although not truly an indoor exposure, is breathing air inside a vehicle (car, truck) that has been contaminated with LA over time through open windows, especially at high source locations (e.g., Rainy Creek Road), or by tracking in LA-contaminated soil or dust from other locations on clothing or shoes. This pathway is expected to be primarily applicable to residents in their private vehicles (including the time they drive to and from work), or to tradespersons who may drive company work vehicles.

3. *Breathing Outdoor Air Near a Soil Disturbance.* When a person engages in an activity that disturbs LA-contaminated soil, dust, or mine waste material, LA will be released into the air, with the highest levels occurring in the immediate proximity of the disturbance. Thus, the person causing the disturbance will usually have the highest exposure. This type of scenario may occur at a variety of residential, commercial, school, or recreational locations, and may include a very wide range of behaviors that disturb the soil, dust, or mine waste material. A few selected examples include:

    - A child playing in dirt in his/her yard
    - An adult performing home yard or garden care activities
    - Children or adults engaging in sports or exercise at schools or other public recreational facilities
    - A tradesperson installing or repairing buried utility lines
    - A tradesperson working on a roof that contains LA deposited from air fallout
    - A tradesperson engaged in maintenance activities along a highway transportation corridor in OU4
    - A visitor participating in recreational activities in OU4.

    This pathway is believed to be of minor concern for commercial workers who work indoors and do not come into contact with outside soils during their work.

Note that most individuals in Libby may be exposed by more than one of these pathways (Peipins et al. 2003). For example, a resident may be exposed while working in his/her yard, while indoors at his/her home, and while visiting public areas. For this reason, exposure and risk evaluations must consider the combined, or cumulative, effect of all exposure scenarios and pathways that apply to individuals in the community.

REFERENCES

Midwest Research Institute. 1982. Collection, analysis, and characterization of vermiculite samples for fiber content and asbestos contamination. Final report. Washington, DC; U.S. Environmental Protection Agency. Contract No. 68-01-5915.

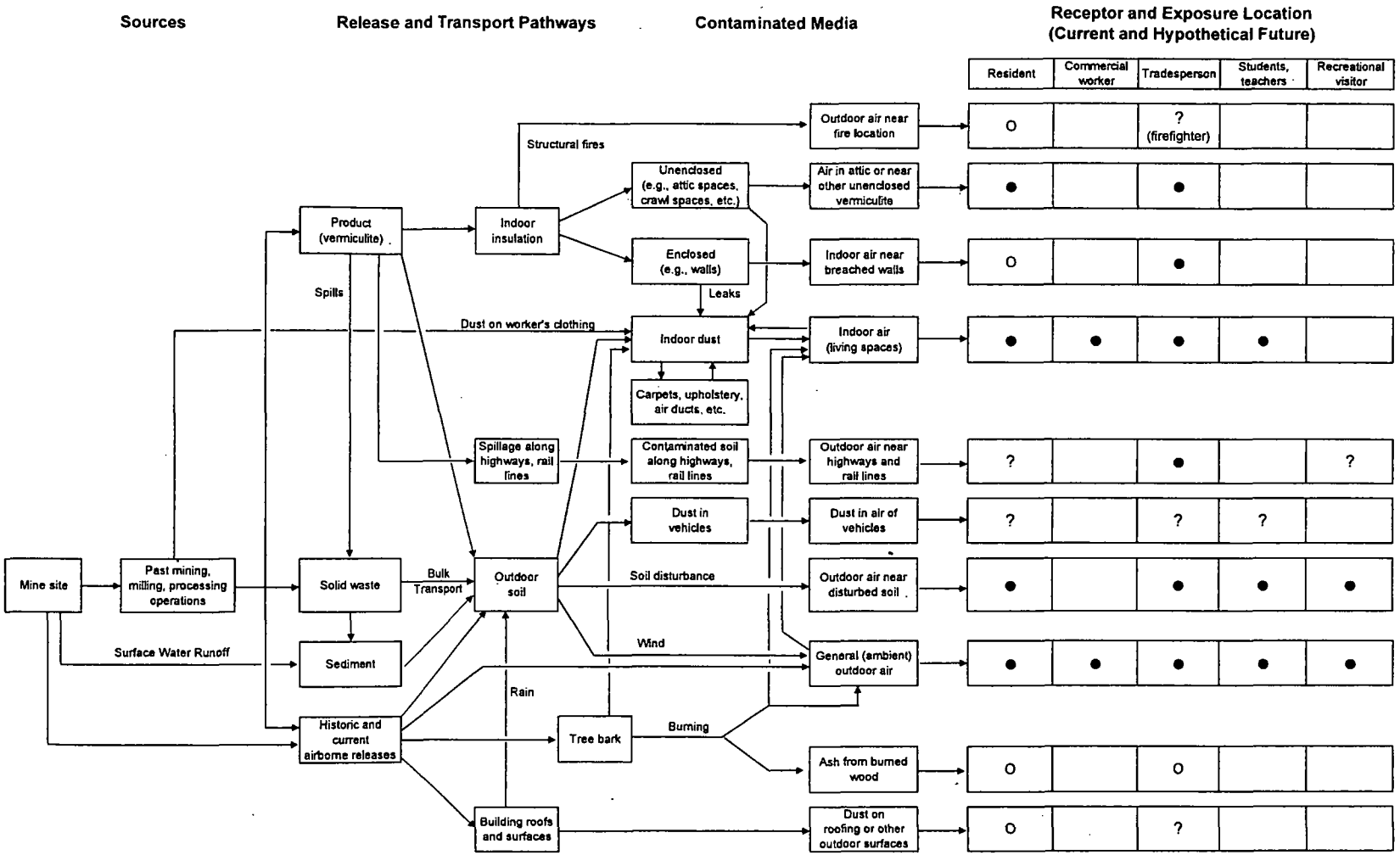
Peipins LA, Lewin M, Campolucci S, Lybarger JA, Miller A, Middleton D, Weis C, Spence M, Black B, Kapil V. 2003. Radiographic Abnormalities and Exposure to Asbestos-Contaminated Vermiculite in the Community of Libby, Montana, USA. Environ Health Perspect 111:1753-1759.

USEPA. 1985. Exposure Assessment for Asbestos Containing Vermiculite. Report #560/5-85-013.

USEPA. 1989. Risk Assessment Guidance for Superfund. Volume I. Human Health Evaluation Manual (Part A). U.S. Environmental Protection Agency, Office of Emergency and Remedial Response. EPA/540/1-89/002.

FIGURE 2. CONCEPTUAL SITE MODEL FOR INHALATION EXPOSURES TO ASBESTOS

Libby Superfund Site -- Operable Unit 4 (Main Residential, Commercial, and Public Areas of Libby)



KEY

●	Pathway is complete and exposure may be significant; quantitative evaluation is warranted
O	Pathway is complete but is believed to be minor in comparison to other pathways; qualitative evaluation is warranted
?	Pathway may be complete but magnitude of exposure is uncertain; further investigation may be necessary
	Pathway is incomplete or believed to be negligible; further evaluation is not warranted

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FIGURE 2. CONCEPTUAL SITE MODEL FOR INHALATION EXPOSURES TO ASBESTOS

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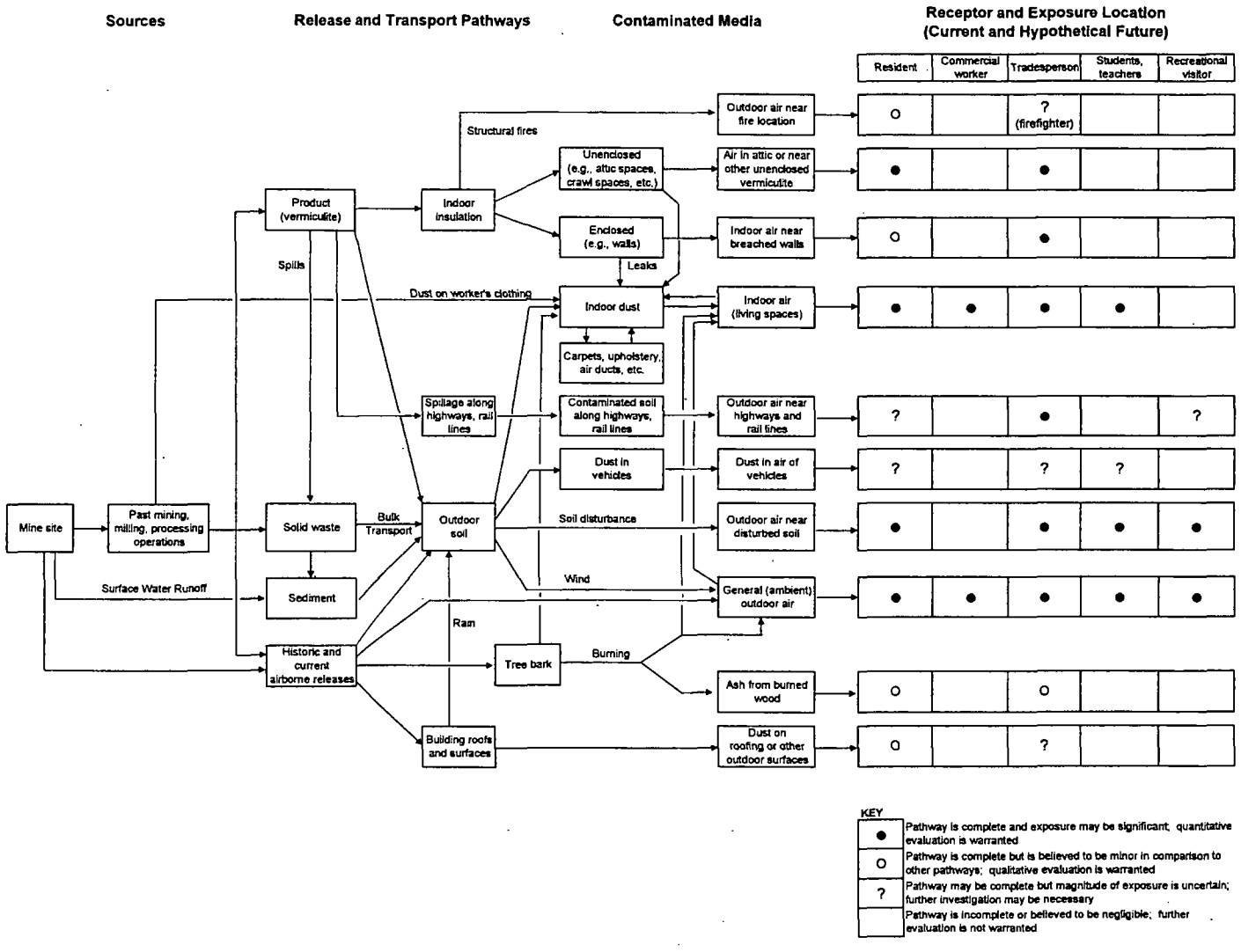

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